

0-20V/2AMP REGULATED DC POWER SUPPLY

FRESHMAN ELECTRONICS

SEMESTER II

FINAL FABRICATION PROJECT

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CIRCUIT DESCRIPTION

In today's world many of our appliances are DC operated. Although many DC appliances have a built-in DC supply, such as boom boxes, televisions, and the like, many do not. Appliances such as mobile CB's, car stereos, portable camcorders, walkmans, ~~and~~ ^{and} the like require an external DC supply that is ripple free.

Certainly battery power will accomplish this out in the field. But what about at home use? The 0-20V, 2Amp Regulated Single Polarity DC Power Supply will help you accomplish this.

The 0-20V, 2Amp Regulated Single Polarity DC Power Supply circuitry consists of a 27V, 2Amp step down transformer(T_1). The 27 VAC is then converted to DC by full-bridge rectification and is then filtered by two capacitors in parallel with the circuit (C_1) and (C_2). Ripple reduction and voltage regulation is then accomplished with a voltage regulator(IC_1). Adjusting the voltage from 0-20V is done with a 5 K Ω , 1 W potentiometer in series with the adjust on the regulator. A second resistor(R_2) is a feedback resistor for IC_1 . After regulation the circuit is filtered with an additional capacitor in parallel with the circuit(C_3). An approximate current reading is taken with an ammeter(M_1), which is in series with the circuit. A voltmeter(M_2) takes an approximate voltage reading in parallel with the circuit.

A power On/Off switch(S_1) is provided for convenience in operating, as is an indicating light(I_1). A 1 amp fuse(F_1) is used for the purpose of circuit protection.

OPERATING INSTRUCTIONS

The 0-20V, 2Amp Regulated DC Power Supply is designed to provide a regulated DC source that can be adjusted from 0V to 20V at 2 amp maximum. Switch(S_1) is ^{used} ~~used~~ to switch the unit on or off. This eliminates the need of unplugging the unit after use. The red indicator light(I_1) can be useful in two ways. It indicates that the unit is energized and also can remind you that the unit is energized when you are done using it.

To use: plug the power supply into a 120VAC, 60 Hz outlet. Before switching the power on, check to see that the voltage setting knob is set back all the way counter clockwise. Then connect the appliance that you wish to power to the power supply by connecting the wires of the appliance to the power supply's binding posts. Unscrew, observe ~~correct~~ polarity. The black post is the negative and the red post is the positive. Screw in.

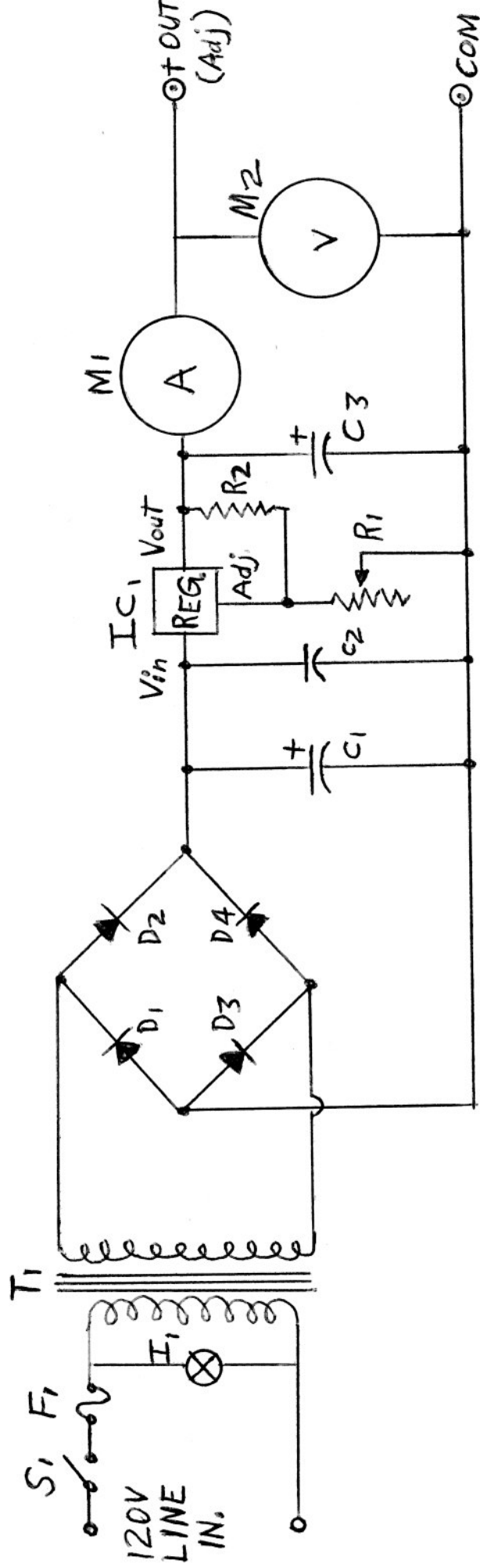
After you have checked polarity and screwed on connections, apply power on. Slowly turn the voltage setting knob clockwise to required voltage needed. Read the voltmeter to see that you are not going over the required limit needed to power the appliance.

It is advised that you do not hook up any appliance that uses more than 2 amps, 20 volts. This will over drive the power supply. If the power supply is over driven then there is a good chance of blowing the fuse. If this occurs, replace with a 1 amp, 250 volt fuse.

SINGLE POLARITY POWER SUPPLY

120VAC INPUT, +1.2-20VDC, 2A. OUTPUT

SCHEMATIC DIAGRAM



S1: S.P.S.T. switch

F1: Fuse, 1A

I1: Indicator light

T1: XFMR, 120VAC/25.2VCT, 2A.

D1-D4: Diode, 100PIV, 50VDC

C1: Capacitor, $\approx 2300\mu\text{f}$, 50VDC

C2: Capacitor, mylar, $0.1\mu\text{f}$, 50VDC

C3: Capacitor, $10\mu\text{f}$, 35VDC (Tantalum)

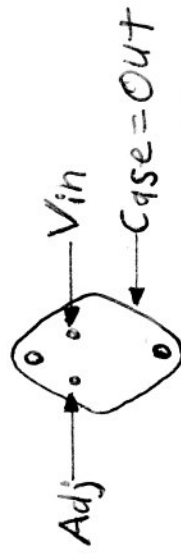
M1: 0-2DC Ammeter

M2: 0-25DC Volt meter

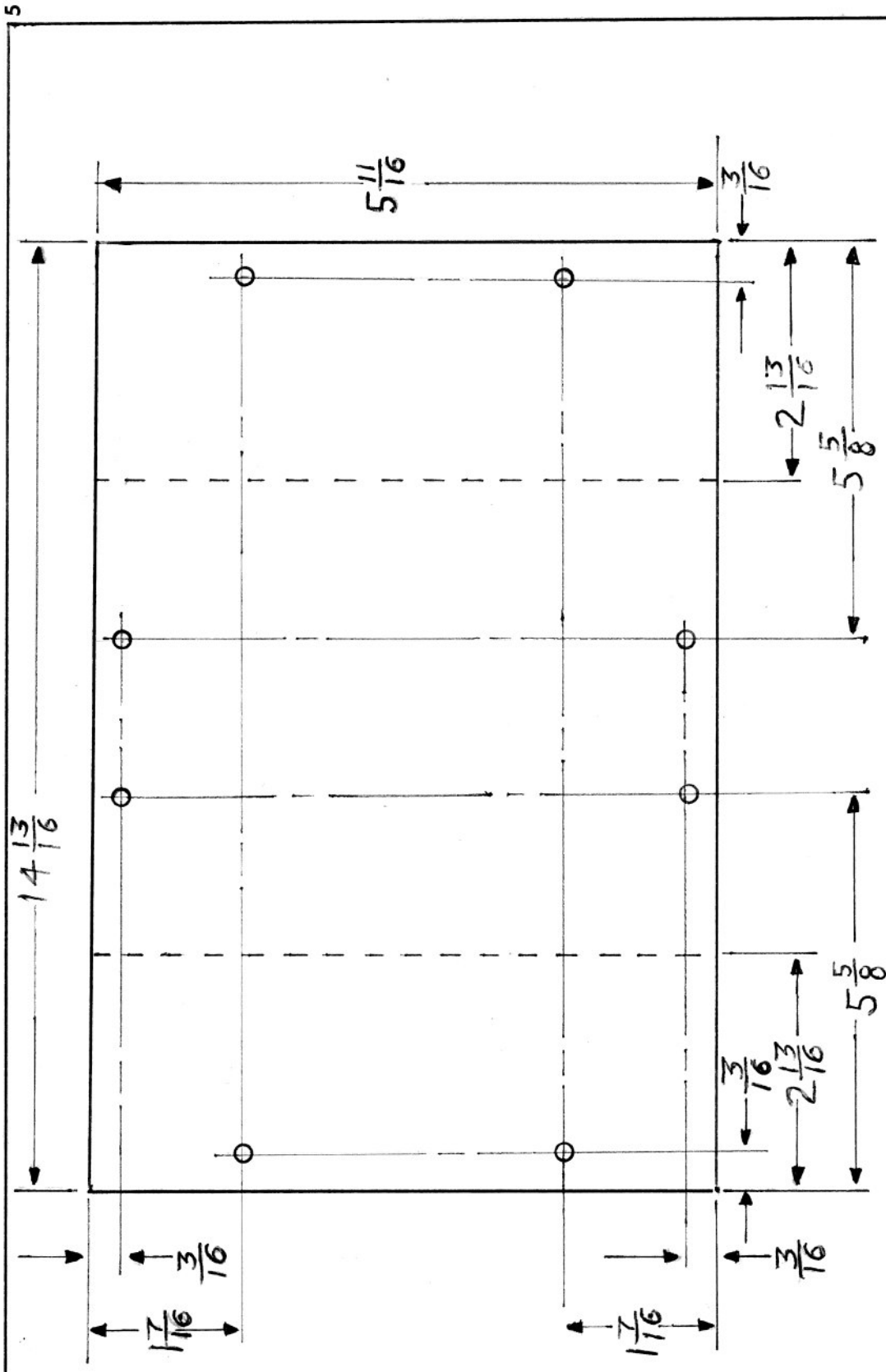
R1: Pot, $5K\Omega$, 1Watt, linear

R2: 220Ω , 1Watt

IC1: LM350K Regulator

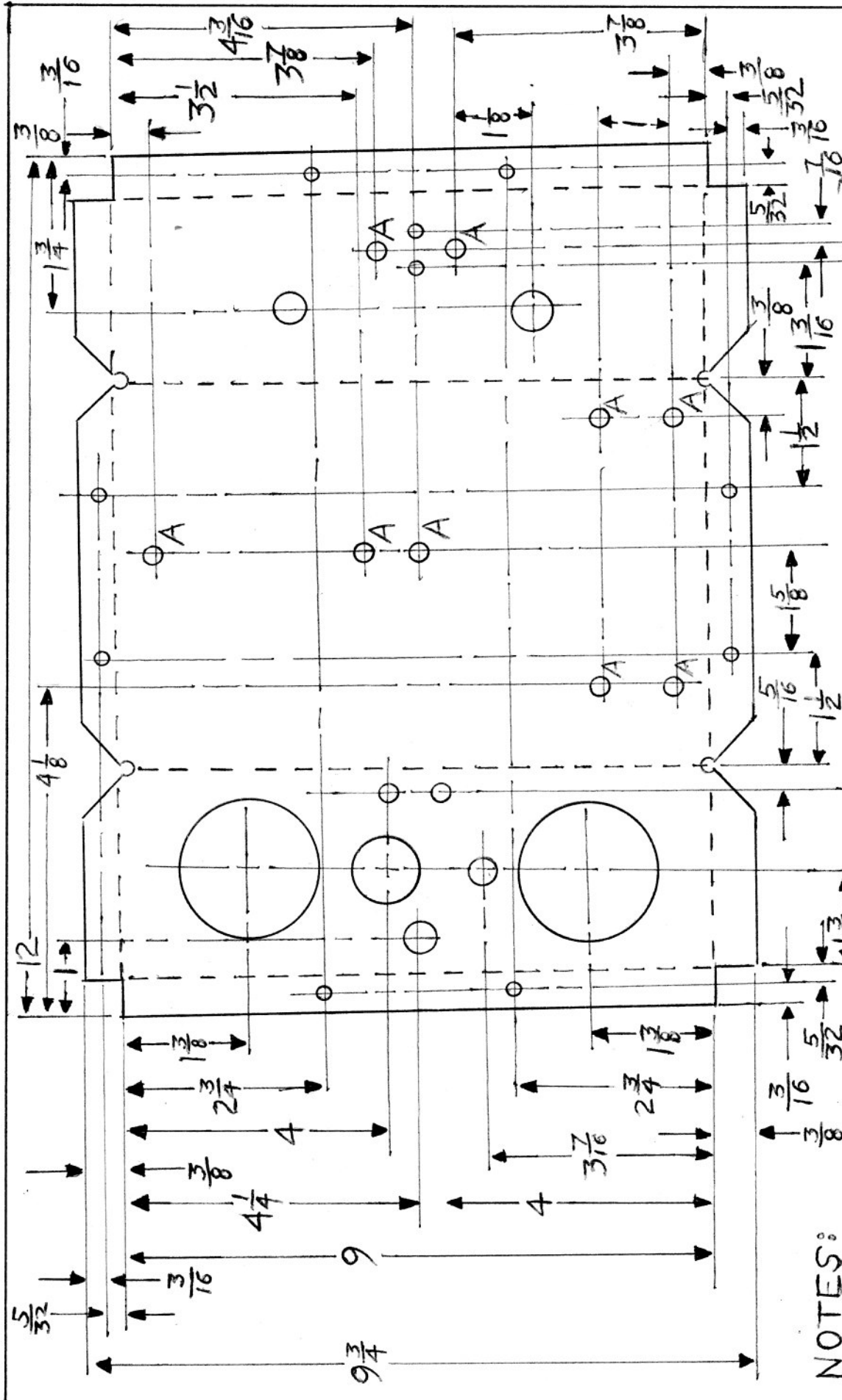


LM350K, Bottom View



NOTES:

- 1) ALL DIMENSION IN INCHES
- 2) DO NOT SCALE DRAWING
- 3) MATERIAL: .040 ALUMINUM
- 4) $\frac{5}{32}$ PUNCH, 8 HOLES
- 5) FINISH: SATIN BLACK ENAMEL
- 6) FORM UP 90° ON DASHED LINES



NOTES:

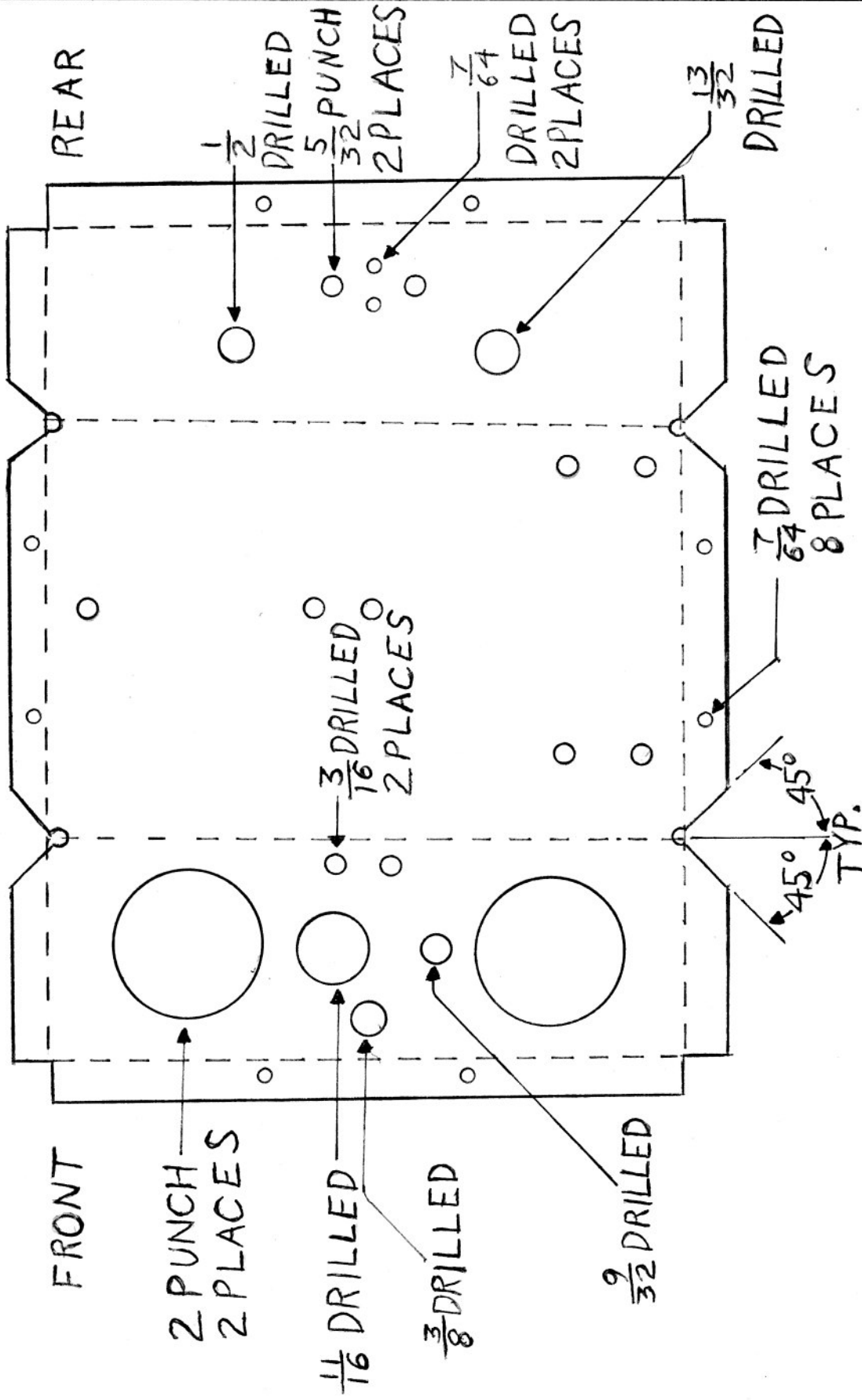
- 1) DO NOT SCALE DRAWING
- 2) MATERIAL: .040" ALUMINUM
- 3) 90° NOTCHES - SEE CHASSIS VIEW 2

4) FINISH - ALMOND WHITE

5) "A" HOLES: 5/32 PUNCH, 9 PLACES

6) ALL DIMENSIONS IN INCHES

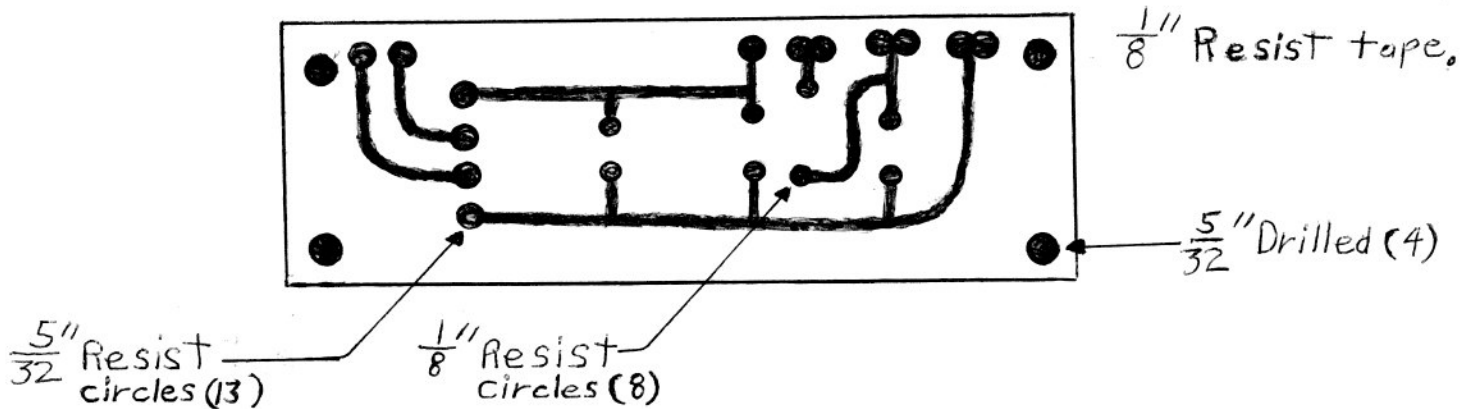
CHASSIS - VIEW 1	DRAWN BY: P SCHOENTHAL	3/29/88	SHEET 1 OF 2
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NOTE:

1) FOLD UP 90° ON DASHED LINES

CIRCUIT BOARD PREPARATIONS



CB₁. Circuit Board Artwork: Foil Pattern Layout

Cut a piece of FR-2 type, $4 \frac{3}{16}$ " x $1 \frac{3}{8}$ " copper circuit board material. Smooth any rough edges. Carefully cut out, or reproduce, the foil pattern layout above, and scotch tape it over the copper side of the circuit board blank.

With a center punch and a small hammer, carefully mark through the paper onto the copper for the center of each circle shown.

Double check to see that all centers have been marked. With hot water and soap and a Scotch-Brite (R) material (NOT STEEL WOOL), scrub and shine the copper until it's absolutely clean. Dry thoroughly. Using the resist circles and tape sizes shown above, lay down the foil pattern on the copper. An x-actoknife or a razor blade will assist in this process. Your hands and the copper must be clean during this process. Do not touch the copper unless it is necessary. When pattern is completed, press down firmly along all conductors and on all pads(circles). This will keep the etching acid from seeping underneath the resist tape and spoiling the circuit board.

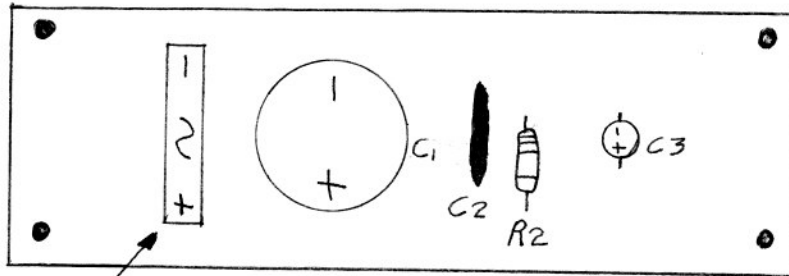
Etch the circuit board in lukewarm ferric-chloride or another suitable etchant until all traces of copper have disappeared from the unmasked areas of the board. Be sure that there are no "bridges" left between adjacent conductors or pads. Rinse immediately with running hot water. Remove the resist material and quickly scrub with soap, hot water, and the Scotch-Brite(R) again. Dry thoroughly.

The circuit board is now ready to be drilled. The $1/8$ " pads are drilled with a #56 drill. The $5/32$ " pads are drilled with a # 50 drill.

Before soldering, clean the copper again until it shines!

CIRCUIT BOARD ASSEMBLY (CB-1)

Component Side



Full Bridge
Rectifier

Mount components as shown, observe polarities and the full-bridge rectifier, C_1 , and C_3 , and solder.

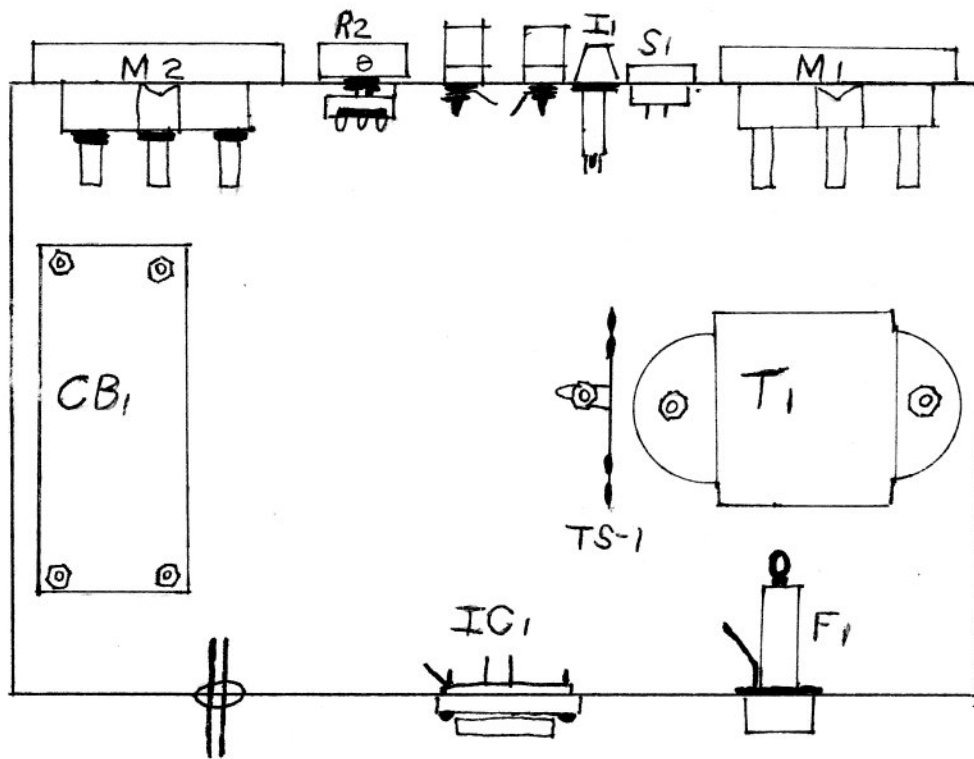
$C_1 = 2,200 \mu\text{f}$ 50VDC Capacitor

$C_2 = .1 \mu\text{f}$ 50V Mylar Capacitor

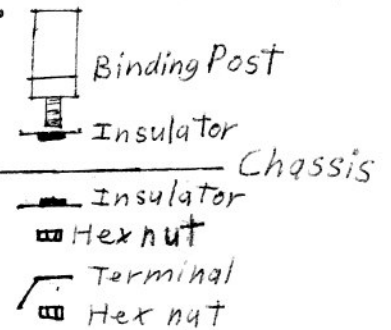
$C_3 = 10 \mu\text{f}$ 35 VDC Tantalum Capacitor

$R_2 = 220\Omega$ 1W Resistor

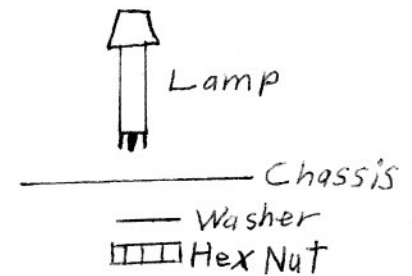
ASSEMBLY OF MAJOR COMPONENT (Top view of chassis)



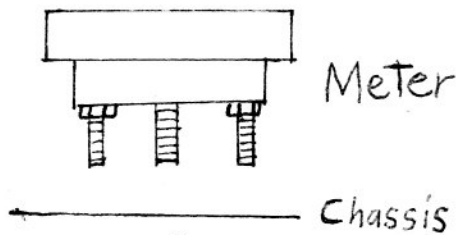
Install binding posts as shown.



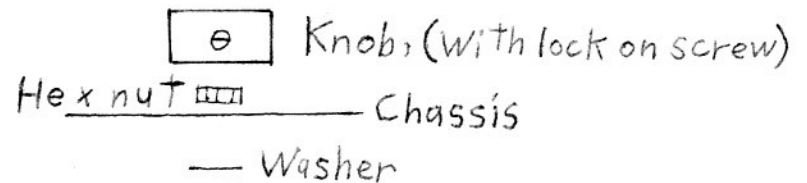
Install I₁ as shown.



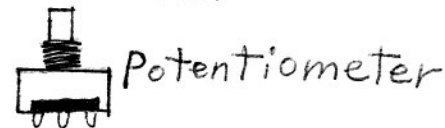
Install M₁ and M₂ as shown.



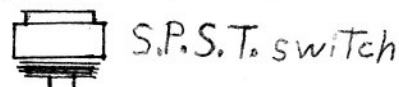
Install R₂ as shown.



Mounting bracket (top view standing up)
Toothed lock washer
Hex nut



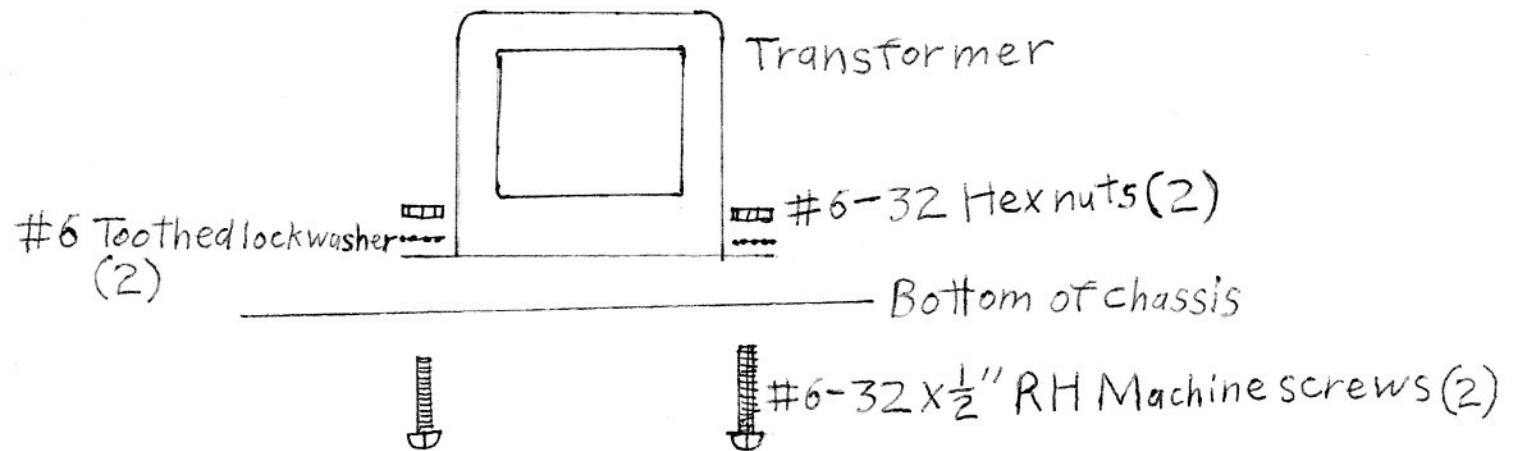
Install S₁ as shown.



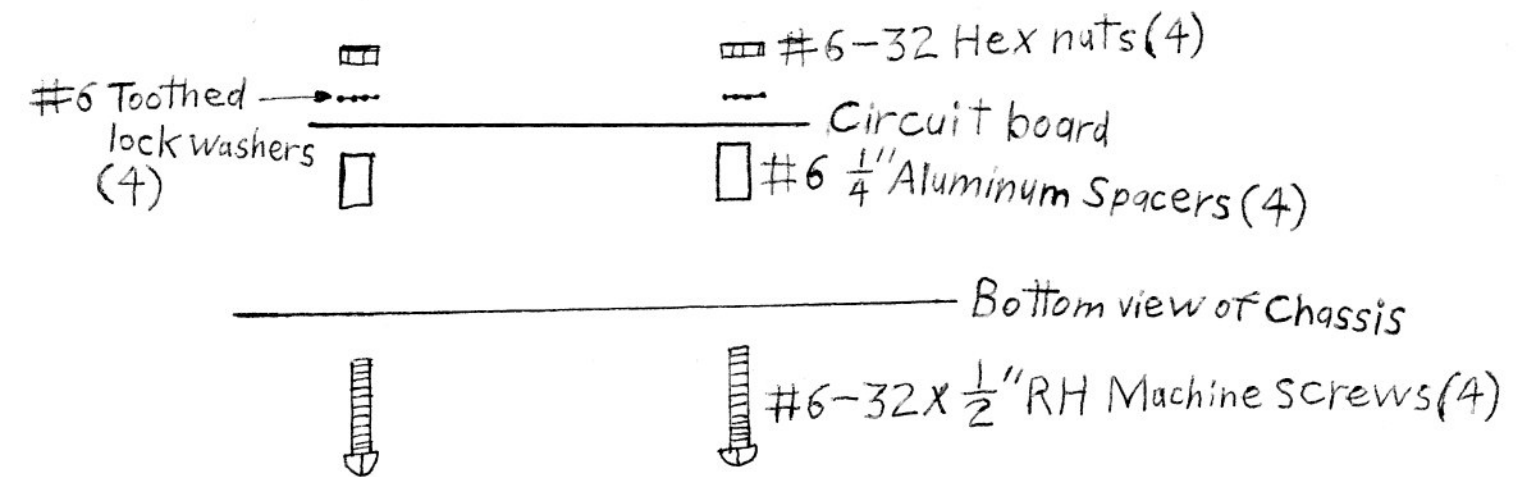
Chassis
Rubber washer
Metallic washer
Plastic nut

ASSEMBLY OF MAJOR COMPONENT (Continue)

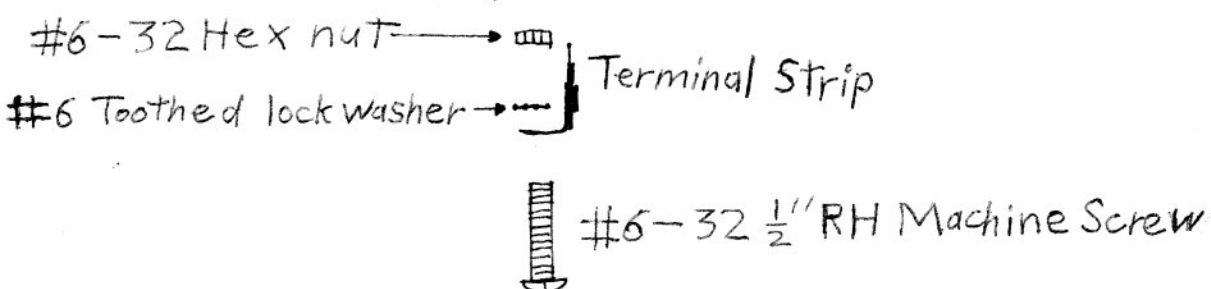
Install T_1 as shown.



Install CB_1 as shown.

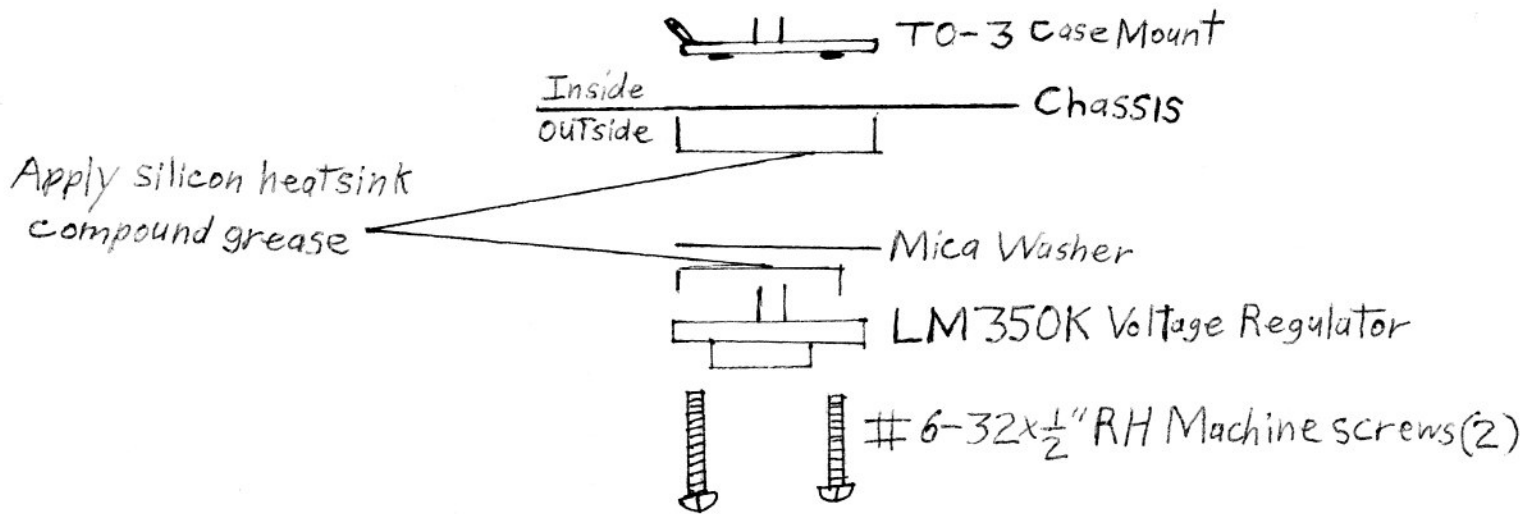


Install TS_1 as shown.

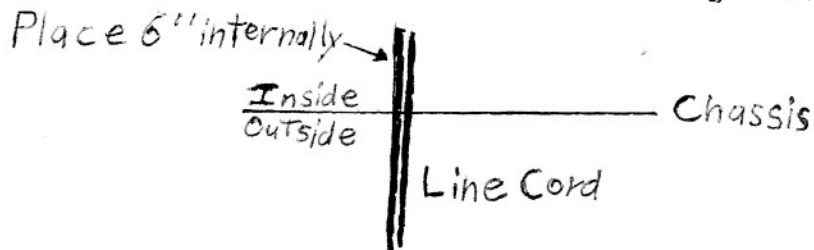


ASSEMBLY OF MAJOR COMPONENTS (Continue)

Install IC₁ as shown.

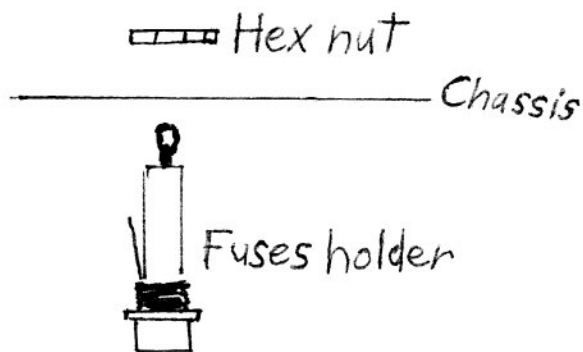


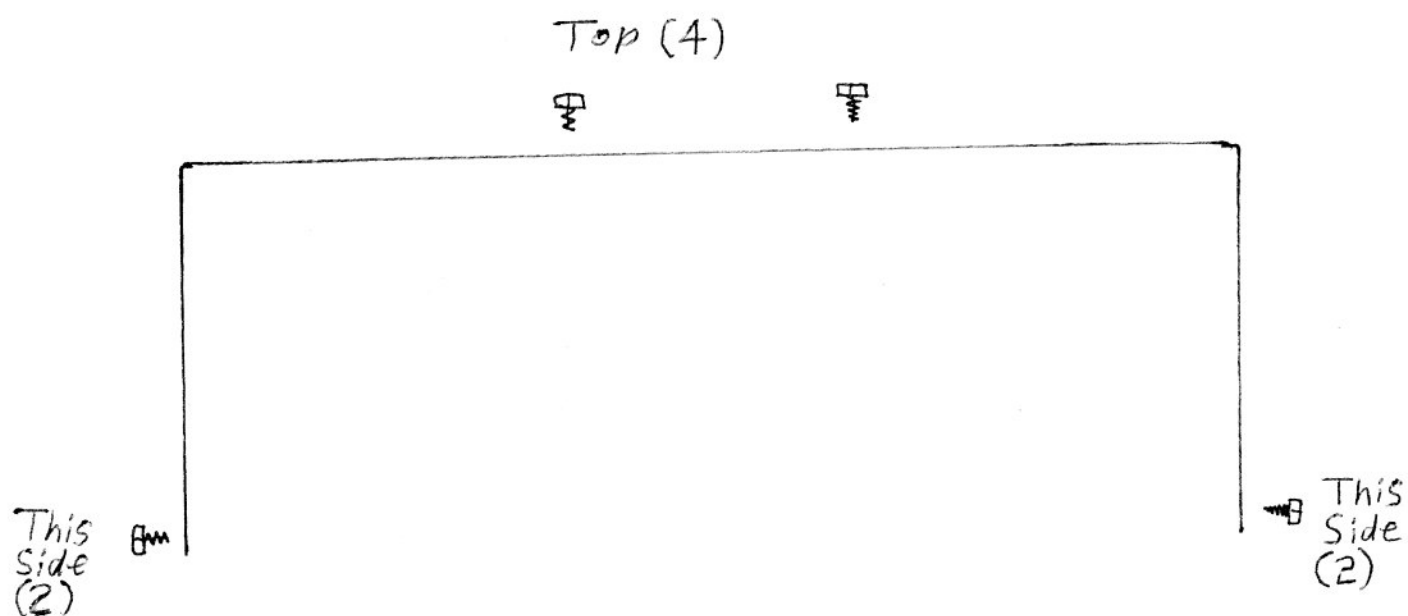
Install brushing as shown



Brushing, (Squeeze on line cord with pliers and insert in hole)

Install F₁ as shown.

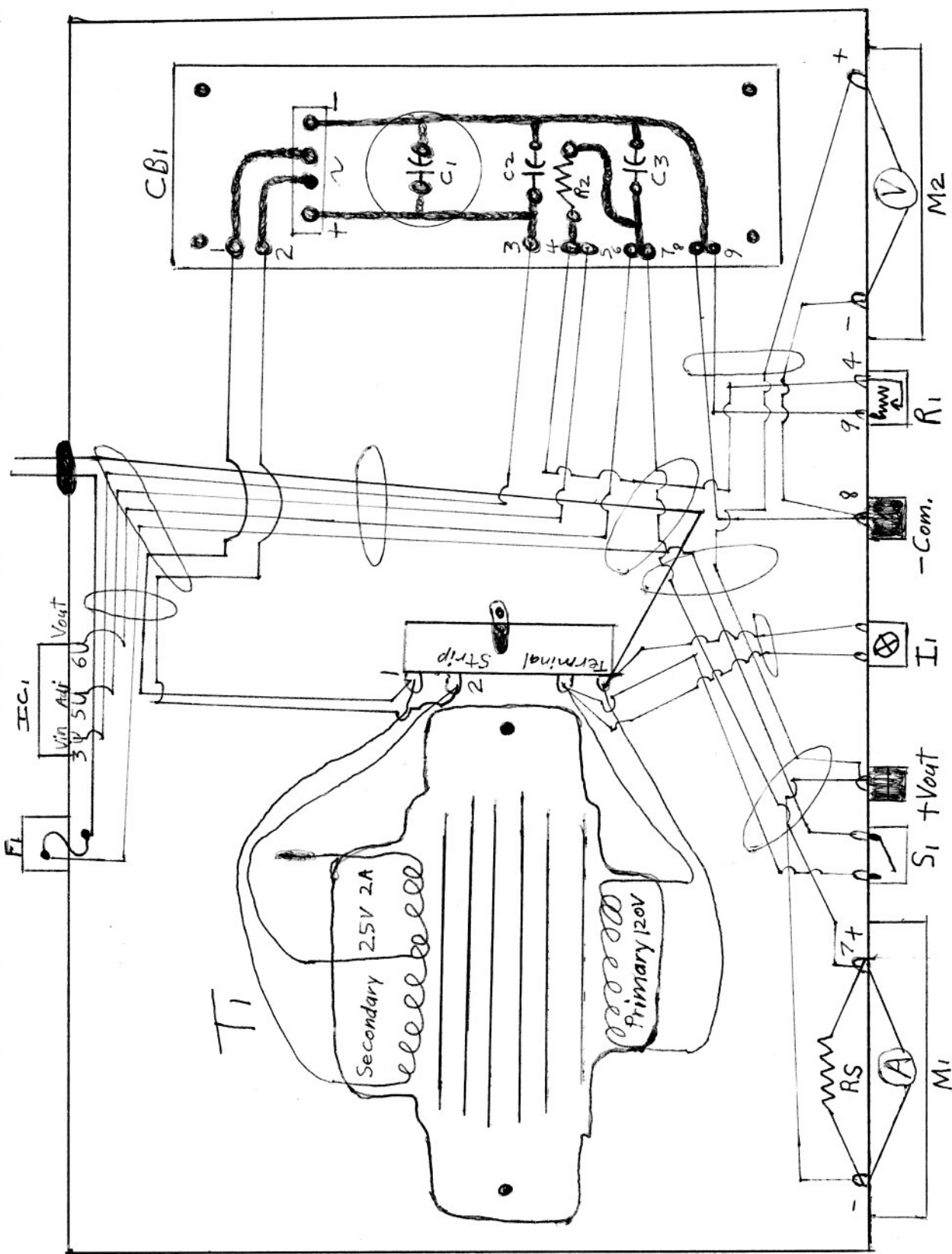


ASSEMBLY OF COVER AND FEET LOCATION

All screws are #6 $\frac{1}{4}$ " Binding Head Sheet Metal Screws,
eight required.

Rubber feet, self-sticking: Apply four to underside of
of chassis in the four corners.

POINT-TO-POINT WIRING (Top View Of Chassis)



INFORMATION ON NEXT PAGE.

POINT-TO-POINT WIRING (CONTINUED)

Except for line cord, all interconnecting wires are #18 stranded.
Trim line cord length as necessary.

Solder all connections except ammeter and voltmeter. Ammeter and voltmeter are connected by lugs.

CONNECTION LENGTHS:

1 to 1 = $4 \frac{1}{4}$ "

2 to 2 = $4 \frac{1}{4}$ "

3 to 3 = $5 \frac{3}{4}$ "

4 to 4 = $5 \frac{1}{2}$ "

5 to 5 = $5 \frac{3}{4}$ "

6 to 6 = 6 "

7 to 7 = 6 "

8 to 8 = 3 "

9 to 9 = $4 \frac{1}{4}$ "

I_1 wires to T_1 primary wires = Both = $2 \frac{1}{2}$ "

S_1 to T_1 primary wire = $2 \frac{1}{4}$ "

S_1 to F_1 = $8 \frac{3}{4}$ "

F_1 to linecord brushing = $3 \frac{1}{2}$ "

M_1 - to 7+ Vout = $3 \frac{3}{4}$ "

M_2 - tp 8-Com. = 3 "

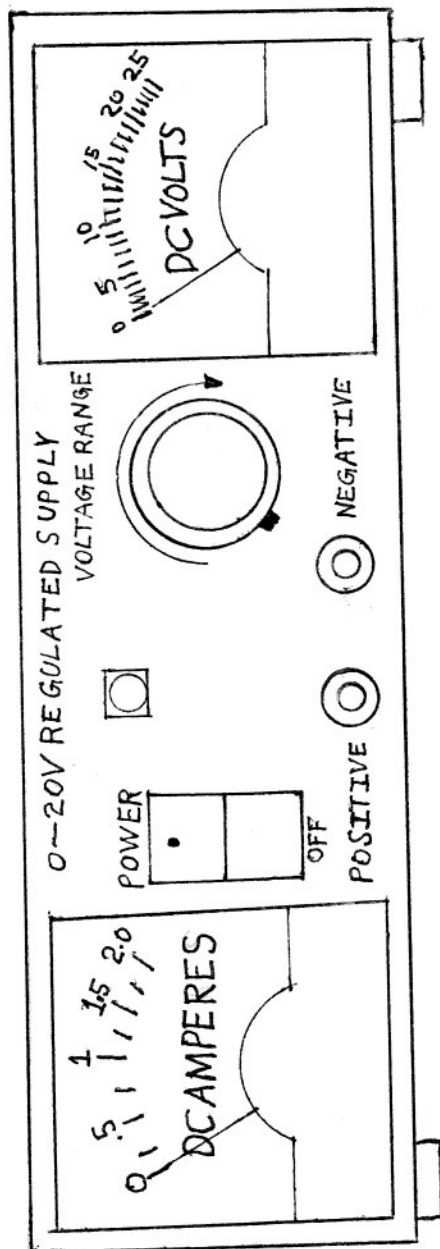
M_2 + to 7+ Vout = 4 "

Line Cord to primary = 5 "

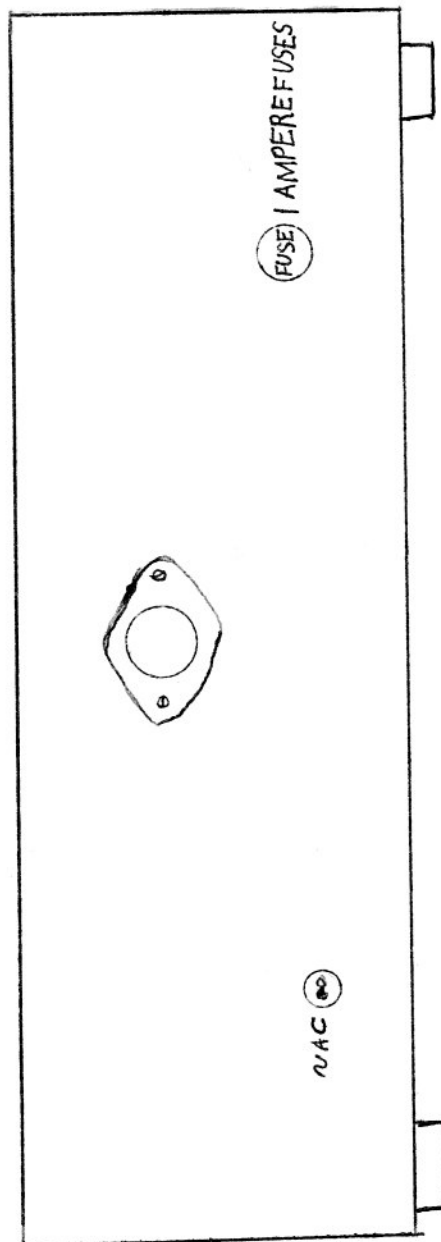
Loops  indicate tie downs. 8 places.

Connections 3, 5, 6, F_1 , S_1 , and CT of secondary on T_1 are heatshrunk.

DECAL PLACEMENT



FRONT



BACK

TEST PERFORMANCE DATAOBJECTIVES:

1. To measure the amount of voltage regulation in the 0-20V Regulated DC Power Supply's output.
2. To measure the amount of line regulation at the power supply's output.
3. To measure line current at full load.

MATERIALS:

1. Digital Multimeter (DVM)
2. Vacuum Tube Voltmeter
3. A High Voltage Rheostat
4. A Variac

PROCEDURES:

1. Plug the probes of the vacuum tube voltmeter into the terminals of the power supply. Observe polarity.
2. Switch on power supply. Slowly turn the voltage range knob until 20 volts is read on the voltmeter. Record this unloaded voltage in Table #1. Power off.
3. Set the DVM to the ohms scale and set the rheostat to maximum resistance. Then set the DVM to the 10 amp scale and connect the DVM to the power supply in series with the rheostat. Leave the voltage range where it is for 20V.
4. Power on. Slowly adjust rheostat until the DVM reads 2 amps. With the vacuum tube voltmeter, measure across the circuit for a voltage reading. Record loaded voltage in Table #1. Power off.
5. Set the vacuum tube voltmeter to 150VAC range. Place the meter's probes into the socket of the variac. Check to see that the variac is set at 0V and power on. Adjust the variac's voltage until you read 132 VAC on the meter. Power off.
6. With the power supply's voltage still left where it is, plug it into the variac. The rheostat and the DVM are still in series with the output terminals. Plug the power supply into the output of the variac. Set the vacuum tube voltmeter to 50VDC range and set it up so it will read across the power supply's terminals.

TEST PERFORMANCE DATA CONTINUED

PROCEDURES CONTINUED:

7. Power on to both the variac and the power supply. Measure the voltage across the power supply's terminals with the power supply still loaded. Record this voltage in Table #2.
8. Power off on both the power supply and the variac. Set the vacuum tube voltmeter again to 150 VAC range. Plug probes into variac's output and power on. Adjust voltage to 108 VAC. Power off.
9. Plug the power supply back into the variac and set vacuum tube voltmeter to measure across the terminal, as in step #6.
10. Repeat step #7 to get the voltage reading.
11. To get both the voltage and line regulation, use the formula:

$$\frac{V \text{ no load} - V \text{ full load}}{V \text{ full load}} (100) = \%$$
- Record V regulation in Table #1.
Record line regulation in Table #2.
12. To get line current readings, leave the power supply's voltage range and the rheostat at the same settings. Take out the DVM from the circuit and reconnect the rheostat to the power supply's terminals.
14. With vacuum tube voltmeter set at 150 VAC, measure the line voltage, but be careful. Then follow step #8, except set the variac to the line voltage.
15. With DVM set at 10amp AC, set one of the DVM's probes to the variac's out put and the other probe to one of the prongs on the power supply's plug. With clip leads, connect the other prong to the other output socket on the variac.
16. Power on to both the variac and the power supply. Read the current on the DVM and record in Table #2. Power off.

N.B. TABLE #1 AND TABLE # 2 are on page 19.

OBSERVATIONS AND CONCLUSIONS

$V_{No\ load}$	$V_{Full\ load}$	% of regulation
20VDC	19.7VDC	1.52%

Table #1

$V_{at\ 132\ VAC\ input}$	$V_{at\ 108\ VAC\ input}$	% of line regulation
19.7VDC	19.02VDC	3.56%
Line current at full load with 120VAC input = .63A		

Table #2

Type of DVM: Micronta LCD Digital Multimer # 22-185

Type of Voltmeter: 13 RCA Analog Vacuum Tube Volt/ohm Meter #WV-98C.

PARTS LIST

<u>MATERIALS</u>	<u>PRICE</u>	<u>CATALOGUE NUMBER</u> (Unless otherwise indicated)	<u>SOURCE</u>
Decals	\$2.69	#270-201	Radio Shack
Circuit Board (Size: 4 3/16" x 1 3/8")	.25		In House
Resist Tape	2.79	#276-1577	Radio Shack
Binding Posts	1.89	#274-66	Radio Shack
Strain Reliefs	.69	#278-1636	Radio Shack
5'5" Line Cord	.79	BS-5004	Radio Shack
Solderless Lug Pack	.99	#64-3030	Radio Shack
Nylon Wire Ties	1.59	#278-1632	Radio Shack
5K Ω W Potentiometer	1.09	#271-1720	Radio Shack
Aluminum Spacers (1/4")	.99	#64-3024	Radio Shack
Terminal Strip Pack	.89	#274-688A	Radio Shack
Voltage Regulator	4.30	#LM 350K	Jameco Electronics
Ammeter (0-1, Without Shunt)	5.69	#147/101	Kelvin Electronics
Voltmeter (0-25V)	6.24	#147/119	Kelvin Electronics
Neon Light	1.79	#272-704	Radio Shack
Tantalum Capacitor (10 μ f 35 VDC)	.68		Radio Shack
Mylar Capacitor (.1 μ f 50V)	.86		Radio Shack
Transformer (25V-2A)	7.48	#147-45	Kelvin Electronics
2,200 μ f 50 Radial Capacitor	1.96		Hornell Electronics
220 Ω 1W Resistor			In House
Full-Wave Bridge Rectifier (100 PIV-4Amp)	1.59	#276-1171	Radio Shack
Self-sticking Cushion Feet	1.29	#64-2342	Radio Shack
Aluminum, chassis (12" x 9 3/4")	.75		In House
Aluminum, cover (14 13/16" x 5 11/16")	.86		In House
Krylon Ruddy Brown Primer	2.78	#1317*	K-Mart
Krylon Statin Black Paint	2.78	*(Not found)*	K-Mart
Krylon Antique White	2.78	#1503*	K-Mart
Krylon Clear	2.78	#1301*	K-Mart
#18 Gauge Solid Wire (7 1/2 Ft.)			In House
Knob	.99	#274-433	Radio Shack
SPST Switch	1.89	#275-690	Radio Shack

* Product Number

PARTS LIST CONTINUED

<u>MATERIALS</u>	<u>PRICE</u>	<u>CATALOGUE NUMBER</u>	<u>SOURCE</u>
1 Amp Fuse	\$0.15		In House
Fuse Holder	.83		In House
Nine #6-32x $\frac{1}{2}$ " R.H.			
Machine Screws			
(@ \$0.03)	.27		Sentry Hardware
Seven #6-32 Hex Nuts			
(@\$0.04)	.28		Sentry Hardware
Seven #6 Internal Tooth			
Lockwashers			
(@\$0.05)	.35		Sentry Hardware
Eight #6x $\frac{1}{4}$ " Binding			
Head Sheet Metal Screws			
(@\$0.04)	.32		N.A.P . A.
T0-3 Insulating Mica			
Washer	.15		In House
Heatshrink			In House
Heatsink			
Silicone Grease			In House

MATERIAL SOURCES

1. Carter Hardware(Sentry)
130 N. Main Street
Wellsville, New York
14895
2. Hornell Electronics
286-288 Main Street
Hornell, New York
14843
3. Jameco Electronics
1021 Howard Avenue
San Carlos, California
94070
4. Kelvin Electronics
P.O. Box #8
1900 New Highway
Farmingdale, New York
11735
5. K-Mart
Bolivar Road
Wellsville, New York
14895
6. NAPA
80 S. Main Street
Wellsville, New York
14895
7. Ontario Metal Supply
3025 Wintan Road, South
Rochester, New York
14623
8. Radio Shack
Ames Plaza
Route # 417
Wellsville, New York
14895